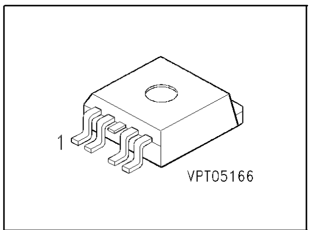
# Smart Lowside Power Switch

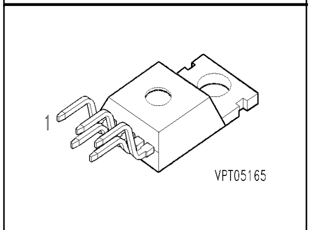
## Features

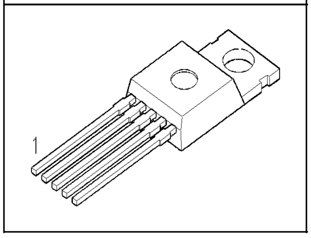
- Logic Level Input
- Input Protection (ESD)
- Thermal Shutdown
- Overload protection
- Short circuit protection
- Overvoltage protection
- Current limitation
- Maximum current adjustable with external resistor
- Current sense
- Status feedback with external input resistor
- Analog driving possible

## Product Summary

| | | | |
|---|---|---|---|
| Drain source voltage | $V_{DS}$ | 60 | V |
| On-state resistance | $R_{DS(on)}$ | 28 | mΩ |
| Current limit | $I_{D(lim)}$ | 6 | A |
| Nominal load current | $I_{D(ISO)}$ | 12 | A |
| Clamping energy | $E_{AS}$ | 4000 | mJ |



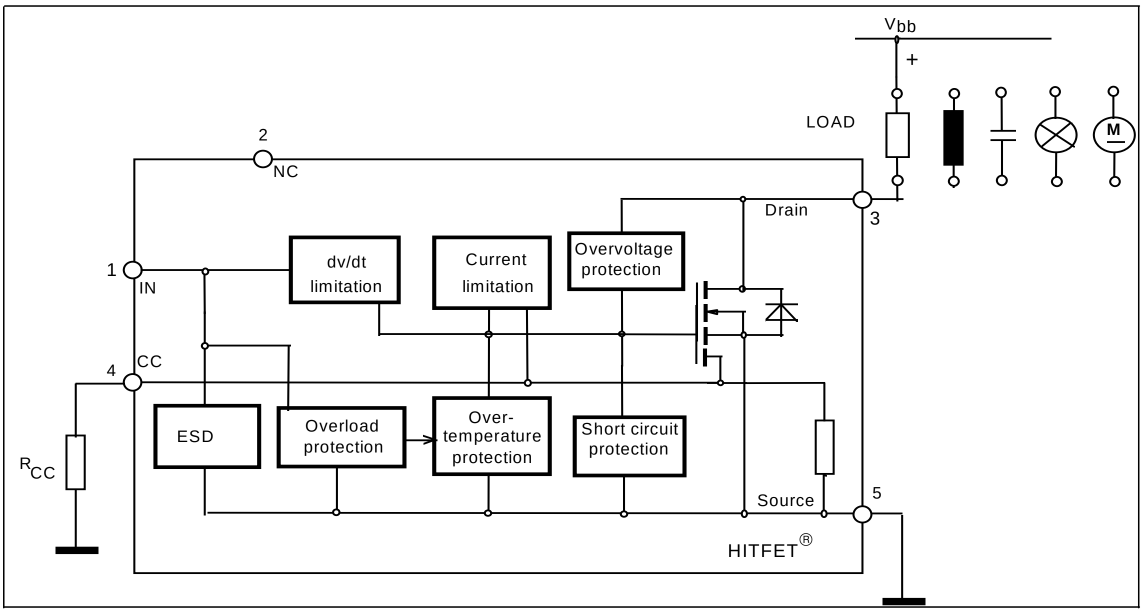




## Application

- All kinds of resistive, inductive and capacitive loads in switching or linear applications
- µC compatible power switch for 12 V and 24 V DC applications
- Replaces electromechanical relays and discrete circuits

## General Description

N channel vertical power FET in Smart SIPMOS® chip on chip technology. Fully protected by embedded protected functions.



**Maximum Ratings at Tj = 25 °C unless otherwise specified**

| Parameter | Symbol | Value | Unit |
|---|---|---|---|
| Drain source voltage | $V_{DS}$ | 60 | V |
| Drain source voltage for short circuit protection<br>$R_{CC}$ = 0 Ω<br>without $R_{CC}$ | $V_{DS(SC)}$ | <br>15<br>50 | |
| Continuous input current [1]<br>-0.2V ≤ $V_{IN}$ ≤ 10V<br>$V_{IN}$ < -0.2V or $V_{IN}$ > 10V | $I_{IN}$ | <br>no limit<br>$\vert I_{IN} \vert \leq 2$ | mA |
| Operating temperature | $T_j$ | - 40 ... +150 | °C |
| Storage temperature | $T_{stg}$ | - 55 ... +150 | |
| Power dissipation<br>$T_C$ = 25 °C | $P_{tot}$ | 149 | W |
| Unclamped single pulse inductive energy<br>$I_{D(ISO)}$ = 12 A | $E_{AS}$ | 4000 | mJ |
| **E**lectro**s**tatic **d**ischarge voltage (Human Body Model) according to MIL STD 883D, method 3015.7 and EOS/ESD assn. standard S5.1 - 1993 | $V_{ESD}$ | 3000 | V |
| Load dump protection $V_{LoadDump}$[2] = $V_A$ + $V_S$<br>$V_{IN}$=low or high; $V_A$=13.5 V<br>$t_d$ = 400 ms, $R_I$ = 2 Ω, $I_D$=0,5*12A<br>$t_d$ = 400 ms, $R_I$ = 2 Ω, $I_D$= 12A | $V_{LD}$ | <br><br>100<br>84 | |
| DIN humidity category, DIN 40 040 | | E | |
| IEC climatic category; DIN IEC 68-1 | | 40/150/56 | |

**Thermal resistance**

| | | | |
|---|---|---|---|
| junction - case: | $R_{thJC}$ | 0.84 | K/W |
| junction - ambient: | $R_{thJA}$ | 75 | |
| SMD version, device on PCB: [3] | $R_{thJA}$ | 45 | |

[1]A sensor holding current of 500 µA has to be guaranted in the case of thermal shutdown (see also page 3)

[2]$V_{Loaddump}$ is setup without the DUT connected to the generator per ISO 7637-1 and DIN 40839

[3]Device on 50mm*50mm*1.5mm epoxy PCB FR4 with 6cm [2] (one layer, 70 µm thick) copper area for Drain connection. PCB is vertical without blown air.

## Electrical Characteristics

| Parameter<br>at $T_j$=25°C, unless otherwise specified | Symbol | Values | | | Unit |
|---|---|---|---|---|---|
| | | min. | typ. | max. | |
| **Characteristics** | | | | | |
| Drain source clamp voltage<br>$T_j$ = - 40 ...+ 150°C, $I_D$ = 10 mA | $V_{DS(AZ)}$ | 60 | - | 73 | V |
| Off state drain current<br>$V_{DS}$ = 32 V, $T_j$ = -40...+150 °C, $V_{IN}$ = 0 V | $I_{DSS}$ | - | - | 20 | µA |
| Input threshold voltage<br>$I_D$ = 2,7 mA | $V_{IN(th)}$ | 1.3 | 1.7 | 2.2 | V |
| Input current - normal operation, $I_D$<$I_{D(lim)}$:<br>$V_{IN}$ = 10 V | $I_{IN(1)}$ | - | 35 | 100 | µA |
| Input current - current limitation mode, $I_D$=$I_{D(lim)}$:<br>$V_{IN}$ = 10 V | $I_{IN(2)}$ | - | 270 | 500 | |
| Input current - after thermal shutdown, $I_D$=0 A:<br>$V_{IN}$ = 10 V | $I_{IN(3)}$ | 1000 | 2500 | 4000 | |
| Input holding current after thermal shutdown<br>$T_j$ = 25 °C<br>$T_j$ = 150 °C | $I_{IN(H)}$ | <br>500<br>300 | <br>-<br>- | <br>-<br>- | |
| On-state resistance<br>$I_D$ = 12 A, $V_{IN}$ = 5 V, $T_j$ = 25 °C<br>$I_D$ = 12 A, $V_{IN}$ = 5 V, $T_j$ = 150 °C | $R_{DS(on)}$ | <br>-<br>- | <br>31<br>52 | <br>34<br>68 | mΩ |
| On-state resistance<br>$I_D$ = 12 , $V_{IN}$ = 10 V, $T_j$ = 25 °C<br>$I_D$ = 12 , $V_{IN}$ = 10 , $T_j$ = 150 | $R_{DS(on)}$ | <br>-<br>- | <br>25<br>45 | <br>28<br>56 | |
| Nominal load current (ISO 10483)<br>$V_{IN}$ = 10 V, $V_{DS}$ = 0.5 V, $T_C$ = 85 °C | $I_{D(ISO)}$ | 12 | | | A |

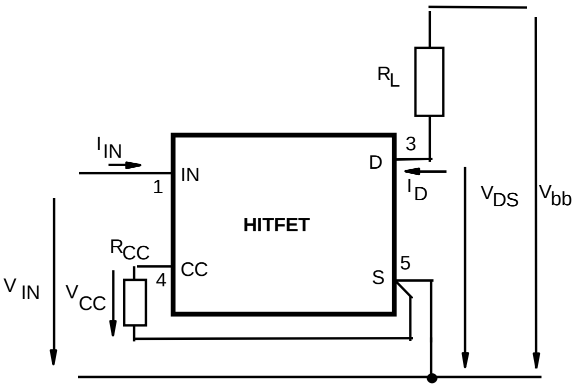
**Electrical Characteristics**

| **Parameter** at $T_j$=25°C, unless otherwise specified | **Symbol** | **Values** min. | typ. | max. | **Unit** |
|---|---|---|---|---|---|
| **Characteristics** | | | | | |
| Initial peak short circuit current limit $V_{IN}$ = 10 V, $V_{DS}$ = 12 V | $I_{D(SCp)}$ | - | 160 | - | A |
| Current limit [1)] | $I_{D(lim)}$ | | | | |
| $V_{IN}$ = 10 V, $V_{DS}$ = 12 V, $t_m$ = 350 µs, $T_j$ = -40...+150 °C, without $R_{CC}$ | | 6 | 12 | 25 | |
| $V_{IN}$ = 10 V, $V_{DS}$ = 12 V, $t_m$ = 350 µs, $T_j$ = -40...+150 °C, $R_{CC}$ = 0 Ω | | 100 | 130 | 170 | |
| **Dynamic Characteristics** | | | | | |
| Turn-on time $V_{IN}$ to 90% $I_D$: $R_L$ = 2,2 Ω, $V_{IN}$ = 0 to 10 V, $V_{bb}$ = 12 V | $t_{on}$ | - | 40 | 100 | µs |
| Turn-off time $V_{IN}$ to 10% $I_D$: $R_L$ = 2,2 Ω, $V_{IN}$ = 10 to 0 V, $V_{bb}$ = 12 V | $t_{off}$ | - | 70 | 170 | µs |
| Slew rate on 70 to 50% $V_{bb}$: $R_L$ = 2,2 Ω, $V_{IN}$ = 0 to 10 V, $V_{bb}$ = 12 V | $-dV_{DS}/dt_{on}$ | - | 1 | 3 | V/µs |
| Slew rate off 50 to 70% $V_{bb}$: $R_L$ = 2,2 Ω, $V_{IN}$ = 10 to 0 V, $V_{bb}$ = 12 V | $dV_{DS}/dt_{off}$ | - | 1 | 3 | |
| **Protection Functions** | | | | | |
| Thermal overload trip temperature | $T_{jt}$ | 150 | 165 | - | °C |
| Unclamped single pulse inductive energy | $E_{AS}$ | | | | mJ |
| $I_D$ = 12 A, $T_j$ = 25 °C, $V_{bb}$ = 32 V | | 4000 | - | - | |
| $I_D$ = 12 A, $T_j$ = 150 °C, $V_{bb}$ = 32 V | | 900 | - | - | |
| **Inverse Diode** | | | | | |
| Inverse diode forward voltage $I_F$ = 5*12A, $t_m$ = 300 µS, $V_{IN}$ = 0 V | $V_{SD}$ | - | 1.13 | - | V |

[1]Device switched on into existing short circuit (see diagram Determination of $I_{D(lim)}$. Dependant on the application, these values might be exceeded for max. 50 µs in case of short circuit occurs while the device is on condition

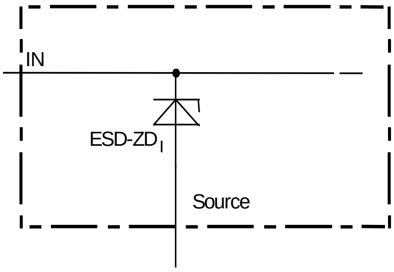
## Block Diagramm

### Terms



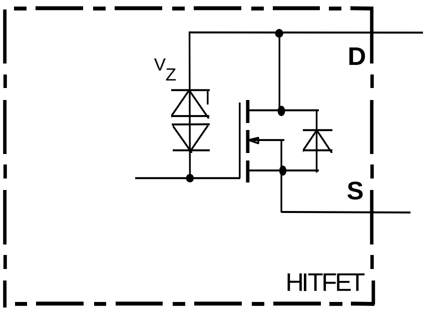

The ground lead impedance of $R_{CC}$ should be as low as possible

### Input circuit (ESD protection)

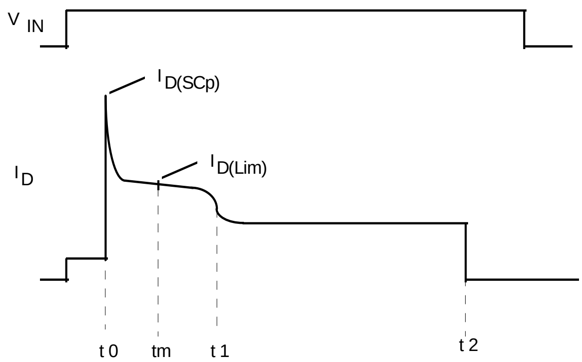



ESD zener diodes are not designed for DC current > 2 mA @ $V_{IN}$>10V.

### Inductive and overvoltage output clamp




### Short circuit behaviour




$t_0$: Turn on into a short circuit

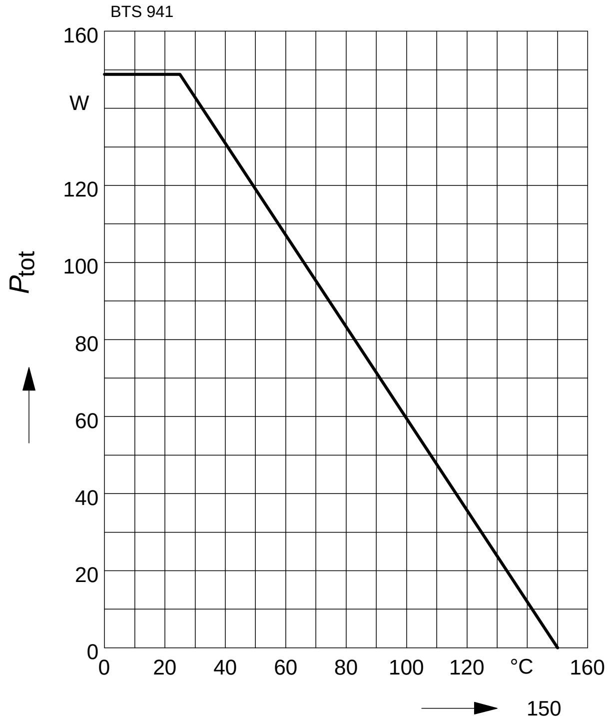
$t_m$: Measurementpoint for $I_{D(lim)}$

$t_1$: Activation of the fast temperature sensor and regulation of the drain current to a level where the junction temperature remains constant.

$t_2$: Thermal shutdown caused by the second temperature sensor, achieved by an integrating measurement.

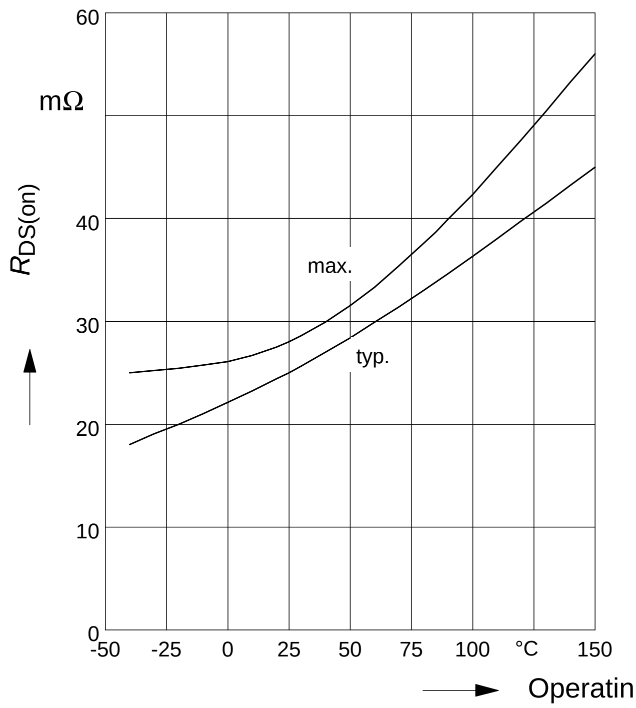
**Maximum allowable power dissipation**

$P_{tot} = f(T_c)$



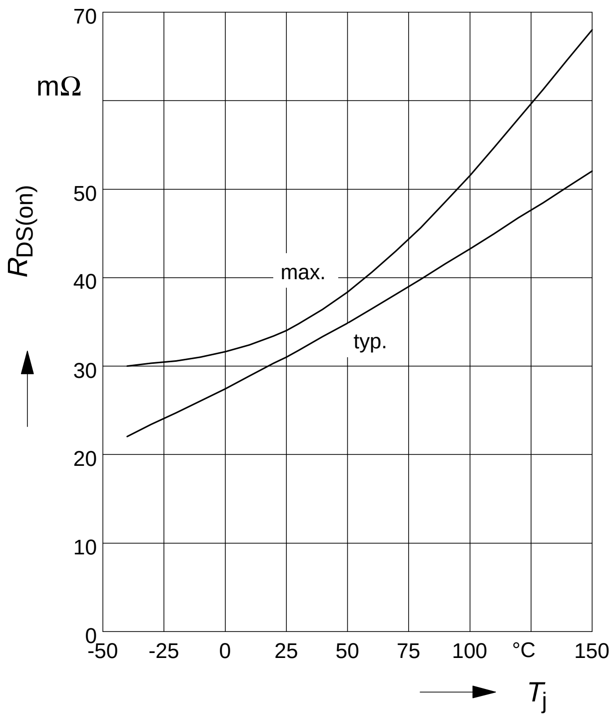

**On-state resistance**

$R_{ON} = f(T_j)$; $I_D$=12A; $V_{IN}$=10V



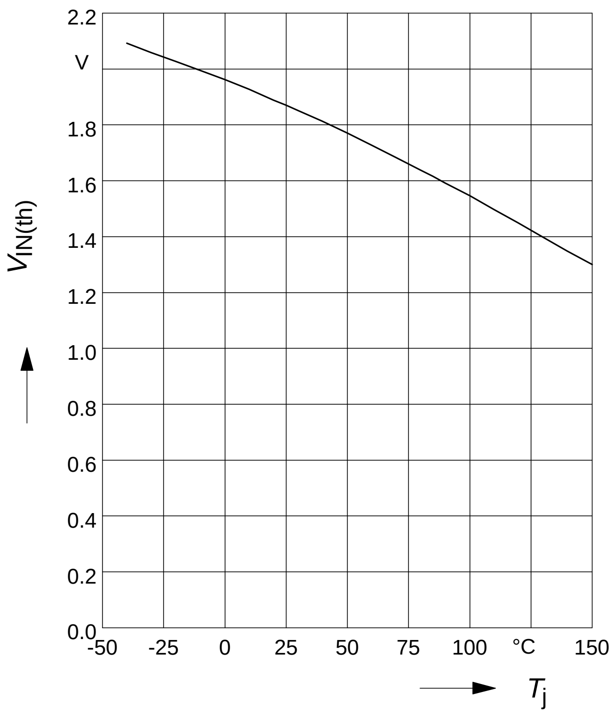

**On-state resistance**

$R_{ON} = f(T_j)$; $I_D$= 12A; $V_{IN}$=5V



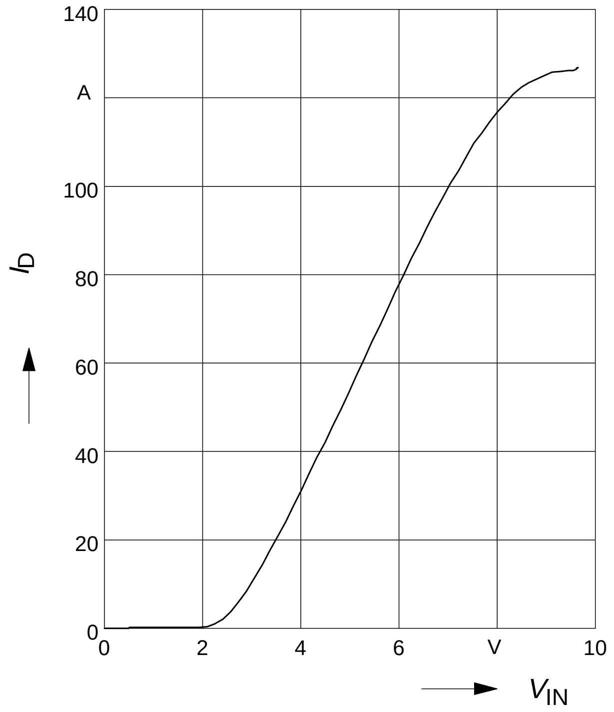

**Typ. input threshold voltage**

$V_{IN(th)} = f(T_j)$; $I_D$=2,7A; $V_{DS}$=12V



**Typ. transfer characteristics**

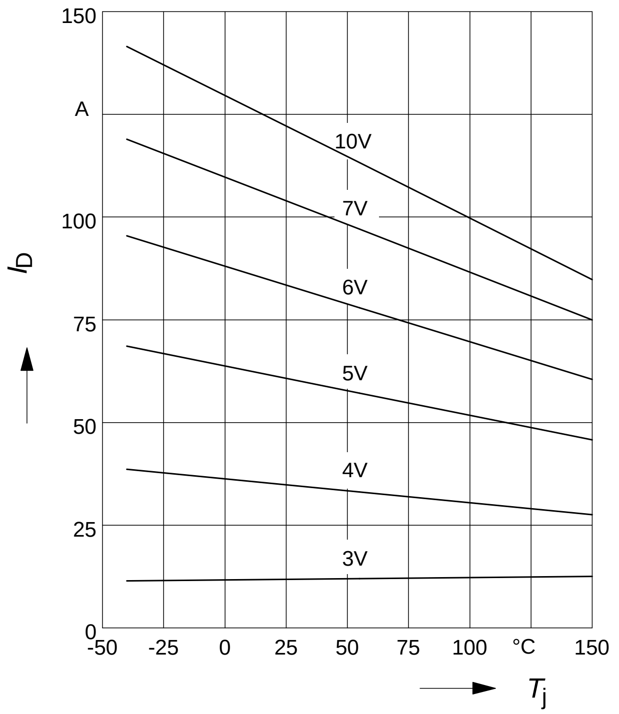
**$I_D$ = f($V_{IN}$);** $V_{DS}$=12V; $T_j$=25°C




**Typ. short circuit current**

**$I_{Dlim}$ = f(Tj);** $R_{CC}$=0Ω, $V_{DS}$=12V

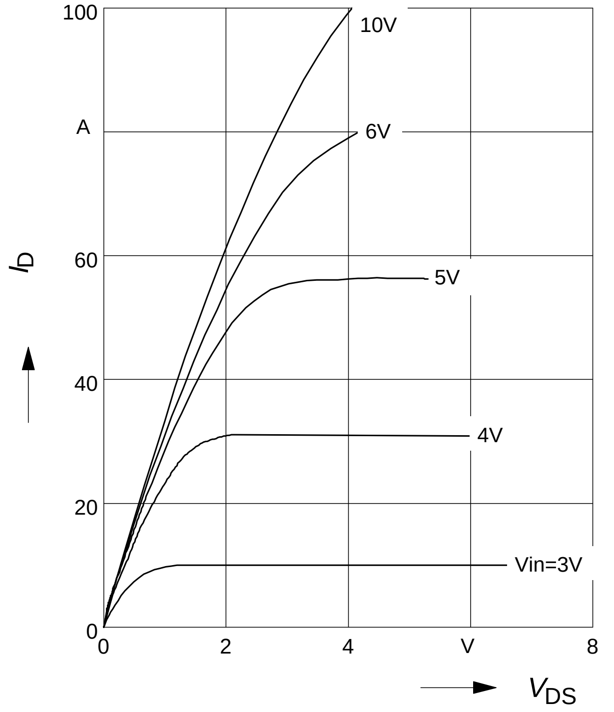
Parameter: $V_{IN}$




**Typ. output characteristic**

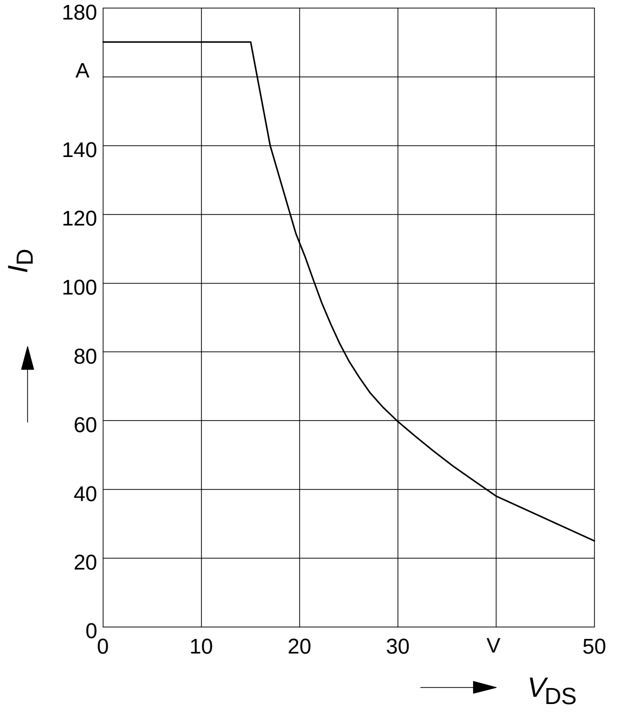
**$I_D$ = f($V_{DS}$);** $T_j$=25°C

Parameter: $V_{IN}$




**Safe Operating Area**

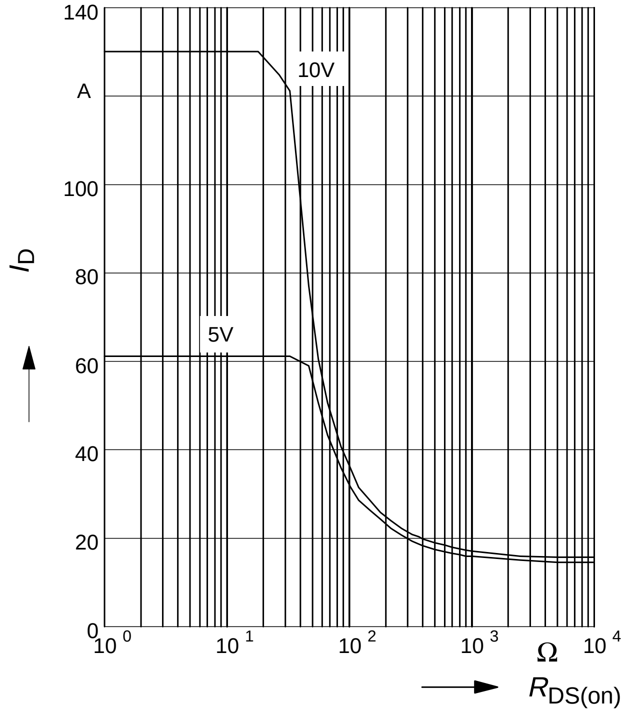
**$I_{D(SC)}$ = f($V_{DS}$);** $T_j$=25°C



**Typ. current limit versus $R_{CC}$**

**$I_{D(lim)} = f(R_{CC})$;** $T_j$=25°C

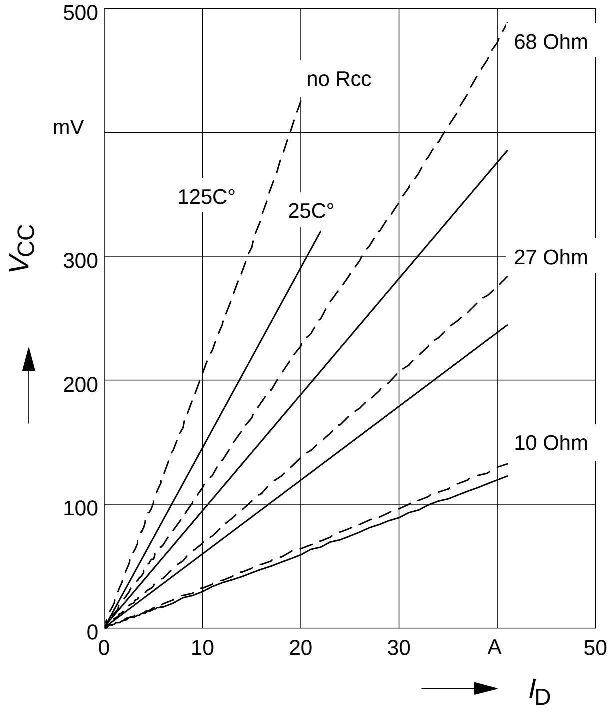
Parameter: $V_{IN}$




**Typ. current sense characteristics**

**$V_{CC} = f(I_D)$;** $V_{IN}$=10V

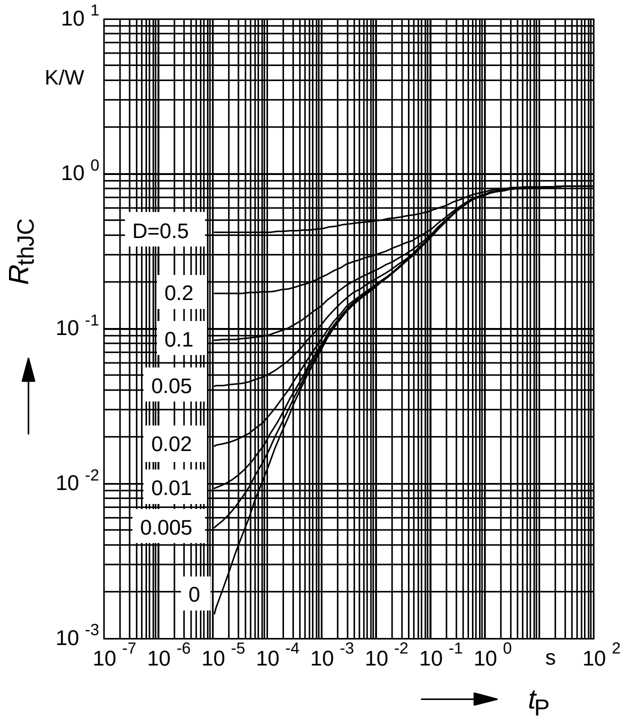
Parameter: $R_{CC}$, $T_j$




**Transient thermal impedance**

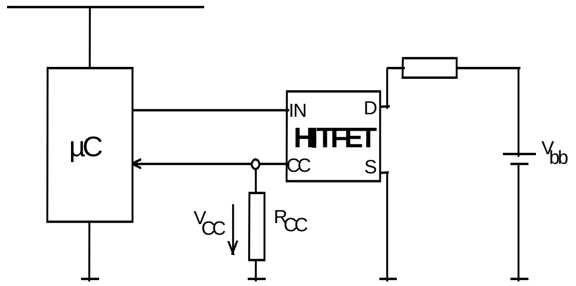
**$Z_{thJC} = f(t_P)$**

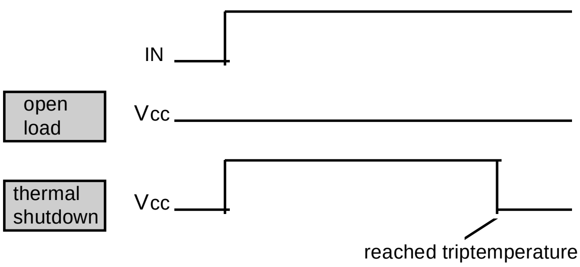
Parameter: $D=t_P/T$



## Application examples:

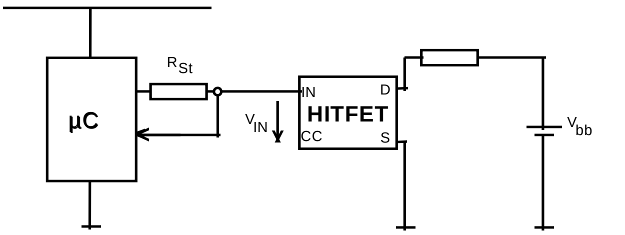
### Current Sense Features and Status Signals




The accuray of Vcc is at each temperature about ±10 %

### Status signal of thermal shutdown by monitoring input current





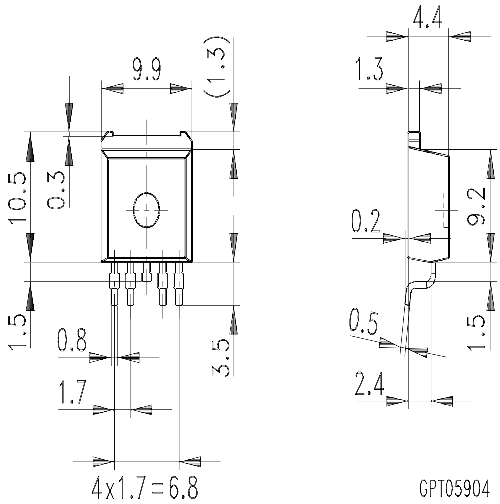


$\Delta V = R_{ST} * I_{IN(3)}$

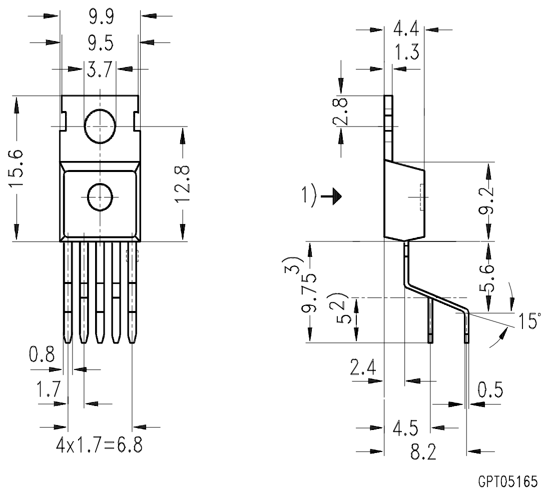
# Package and ordering code

**all dimensions in mm**

Ordering code: Q67060-S6702-A4

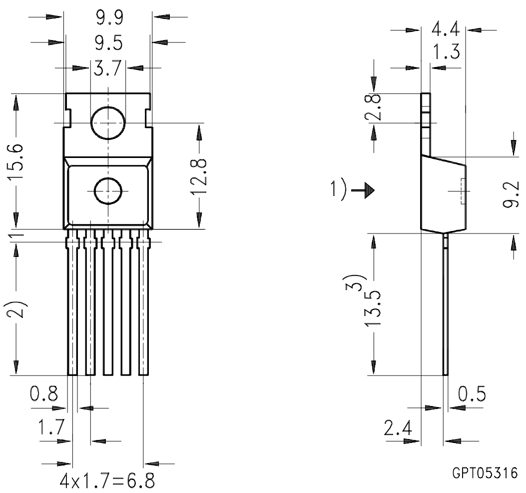



Ordering Code: Q67060-S6702-A2




1) shear and punch direction no burrs this surface
2) min. length by tinning
3) max. 11 mm allowable by tinning

Ordering Code: Q67060-S6702-A3




1) punch direction, burr max. 0.04
2) dip tinning
3) max. 14.5 by dip tinning press burr max. 0.05

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